

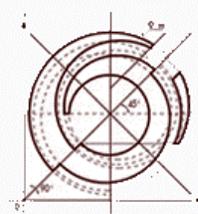
December 11, 2006



**Field Demonstration of Enhanced
Sorbent Injection for Mercury Control
(DOE Cooperative Agreement
DE-FC26-04NT42306)**

**ALSTOM Power Project Manager: Shin G. Kang
DOE/NETL Program Manager: Lynn A. Brickett**

ALSTOM

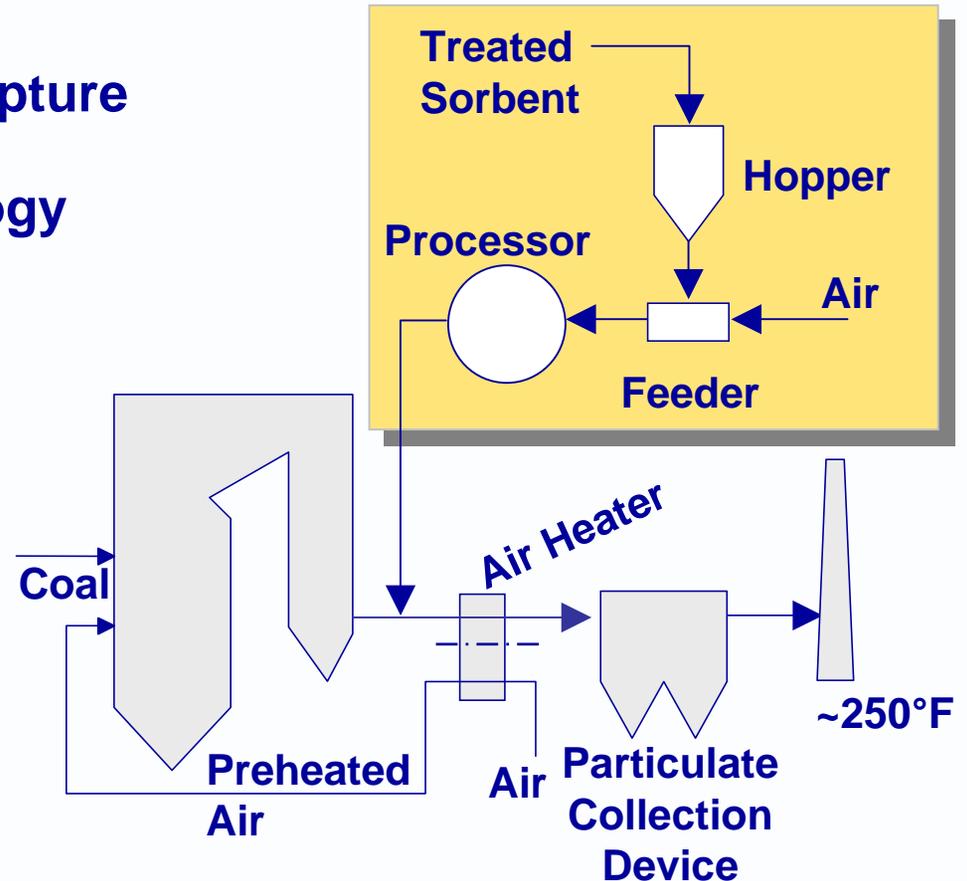


- **ALSTOM's Mer-Cure™ Technology**
- **ALSTOM's DOE Phase II (Round 2) Demonstration Program**
- **First campaign results – PacifiCorp's Dave Johnston Unit 3**
- **Second demo campaign – Basin Electric's Leland Olds Unit 1**
- **Third demo campaign – Reliant Energy's Portland Unit 1**
- **Summary/Next Steps**

- There is no “one-size-fits-all” solution for mercury control
 - Each plant/customer has its own unique needs
 - ALSTOM is developing diverse mercury control options in order to meet unique challenges of customers
 - Coal additives for maximal co-benefits – KNX™
 - Baghouse installation downstream existing air pollution control devices + activated carbon injection
 - Enhanced sorbent injection – **Mer-Cure™**
- **ALSTOM Mer-Cure™ technology** development target
 - Low capital investment (\$5/kW_e)
 - Low operating cost (\$0.50/MWh for low rank coals)
 - Removal efficiency greater than 90%

1. Sorbent formulation
 - Accelerated oxidation/capture
2. Sorbent injection methodology
 - Uniform dispersion
 - Removed mass transfer limitations
3. Sorbent injection location
 - Temperature
 - Residence time

Patented Mer-Cure™ system

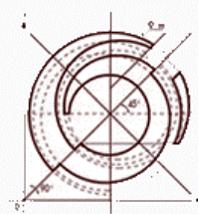


Three-pronged approach significantly enhances performance



Mer-Cure™ Development History **ALSTOM**

- **Bench-scale/pilot-scale development program**
- **First full-scale demonstration of ALSTOM Mer-Cure™ System**
 - Internally funded;
 - Consumers Energy Cobb 5: 170 MWe/PRB-PRB blend/ESP;
- **DOE/NETL Phase II (Round 2) program**
 - PacifiCorp Dave Johnston Unit 3;
 - Basin Electric Leland Olds Unit 1;
 - Reliant Energy Portland Unit 1
- **DOE/NETL Phase III program – under negotiation**
 - LCRA Fayette 3: 480 MW_e/PRB/ESP/WFGD;
 - Reliant Energy Shawville 3: 170 MW_e/E bit. coal/ESP

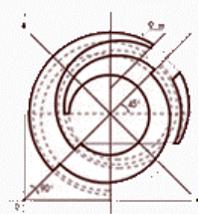


Presentation Outline



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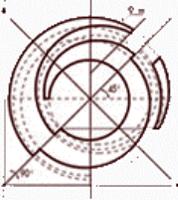
- **Demonstrate Mer-Cure™ technology for mercury capture**
 - **Greater than 70% of “uncontrolled” mercury level**
 - **Units firing coals of various ranks/ESP only**
- **Seven week demo program per site**
 - **1 week baseline measurement**
 - **2 weeks of parametric testing**
 - **4 weeks of long-term testing**
- **Obtain performance data for further development/evaluation of technology**
 - **Economics**
- **Evaluate environmental and balance-of-plant impacts**
 - **Solids characterization**
 - **Backend component performance**



Demonstration Project Team



- **DOE/NETL**
- **ALSTOM Power Inc.**
- **Envergex LLC**
- **PacifiCorp**
- **Basin Electric Power Cooperative**
- **Reliant Energy**
- **UND-EERC**
- **North Dakota Industrial Commission**
- **Minnkota Power**



Mer-Cure™ Demonstration Sites



Utility	PacifiCorp	Basin Electric	Reliant Energy
Host site	Dave Johnston 3	Leland Olds 1	Portland 1
Size (MWg)	240	220	172
Location	Glenrock, WY	Stanton, ND	Portland, PA
Fuel	Wyodak (PRB)	ND lignite	E. Bituminous
APCD (SCA, ft ² /kacfm)	CS-ESP (629)	CS-ESP (320)	CS-ESP (284)
Test Period	June-Aug 2005	Sept-Nov 2005	Mar-Jun 2006

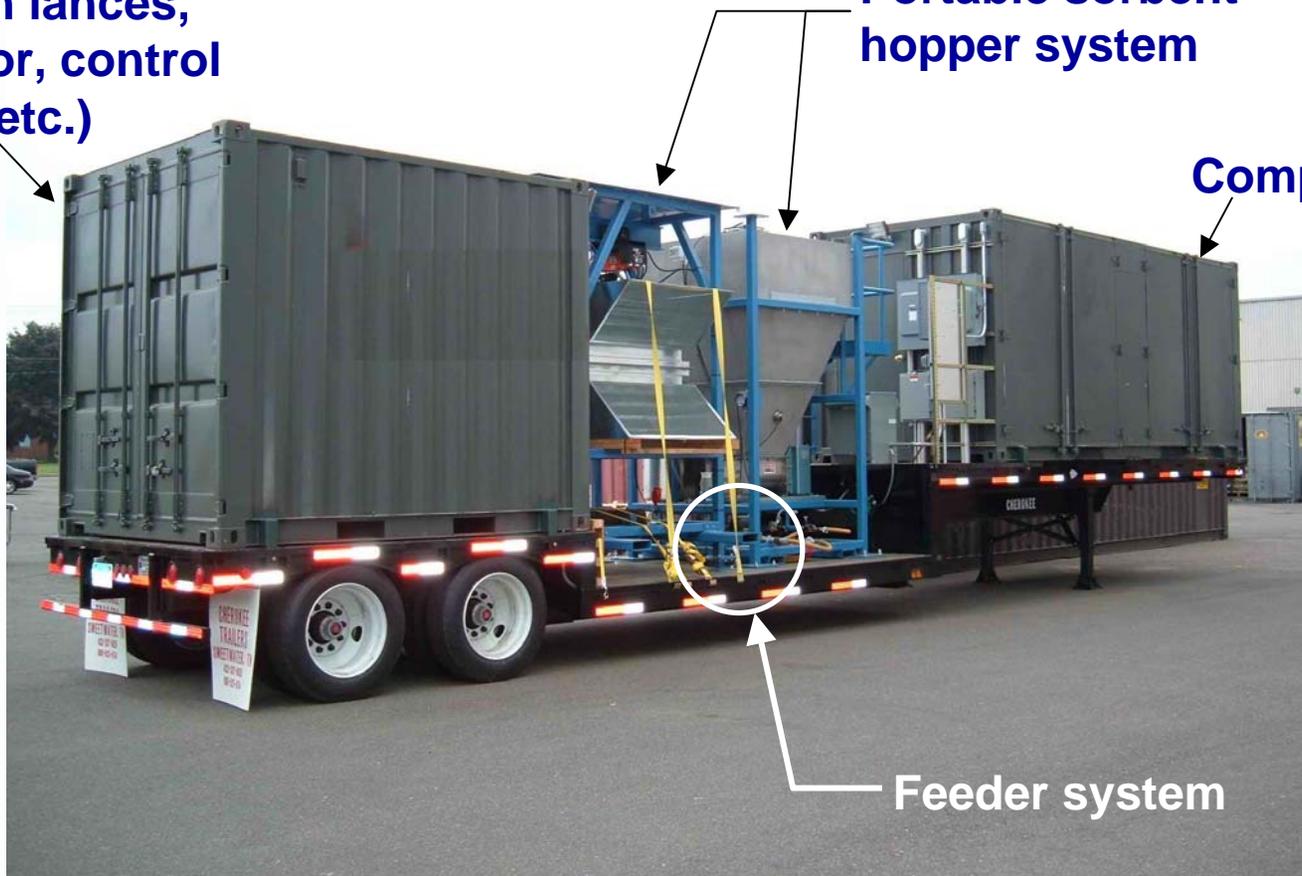
ALSTOM Mer-Cure™ Trailer

ALSTOM

Storage container
(injection lances,
processor, control
system, etc.)

Portable sorbent
hopper system

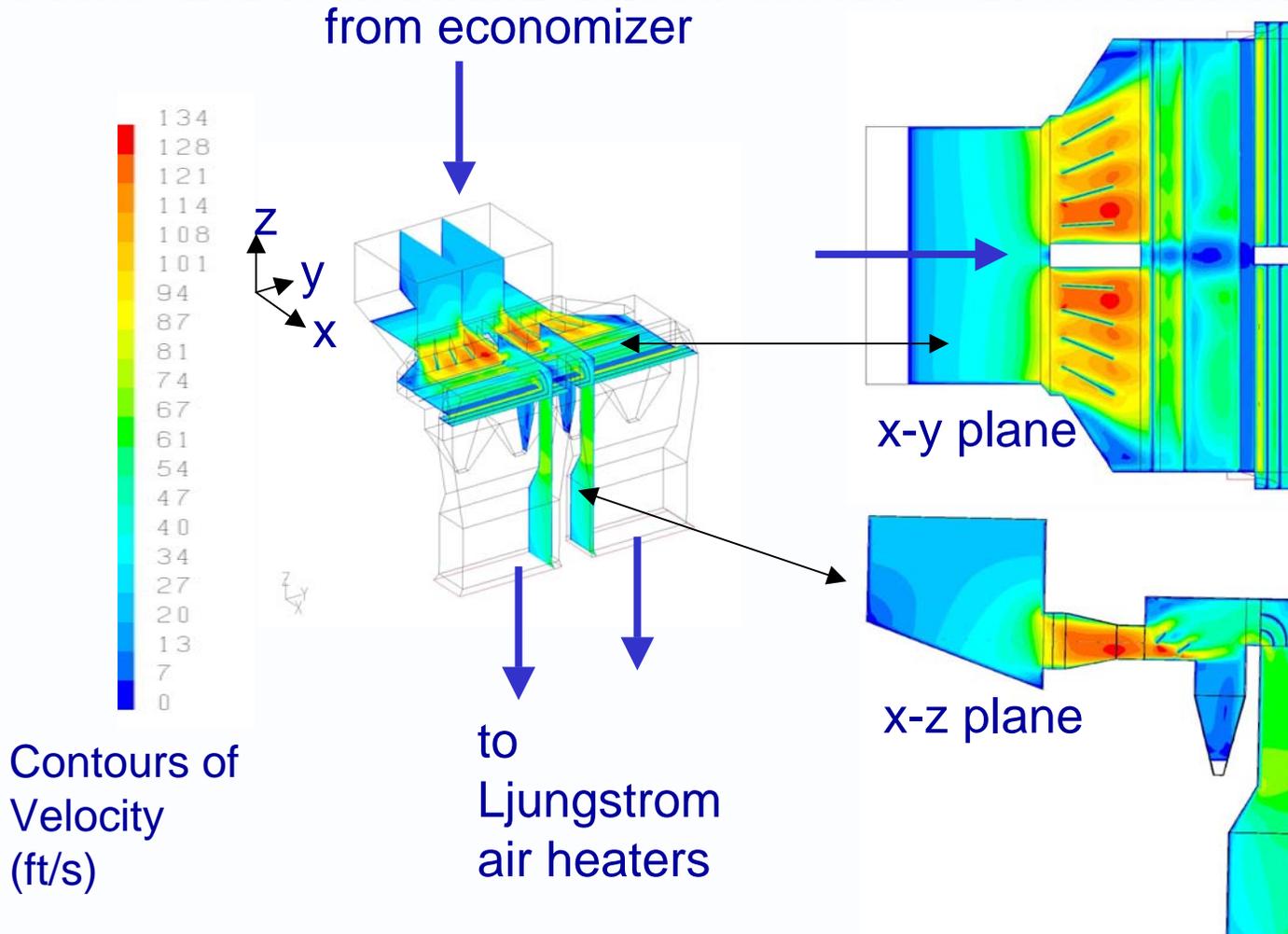
Compressors



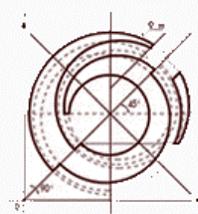
Feeder system

Full-scale testing for PRB-fired units up to 300 MWe

CFD Studies for Injection System Design



Injection lances are designed for uniform mixing



Presentation Outline



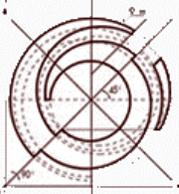
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1st Demo Site - PacifiCorp

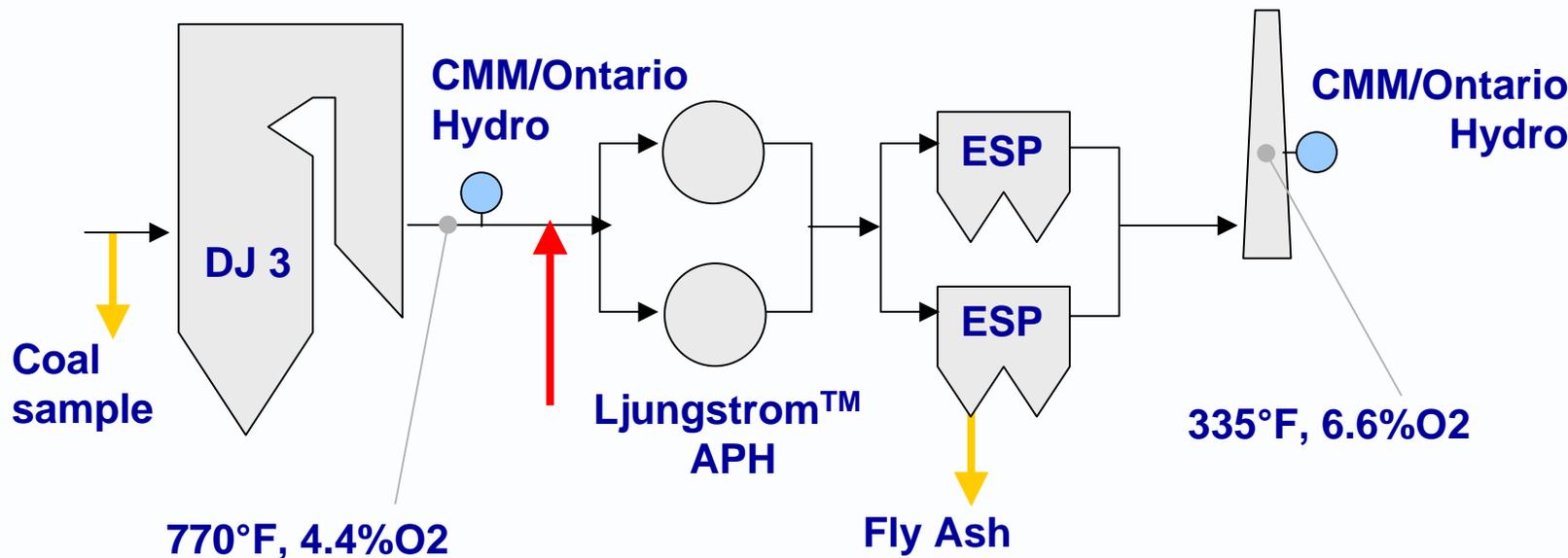


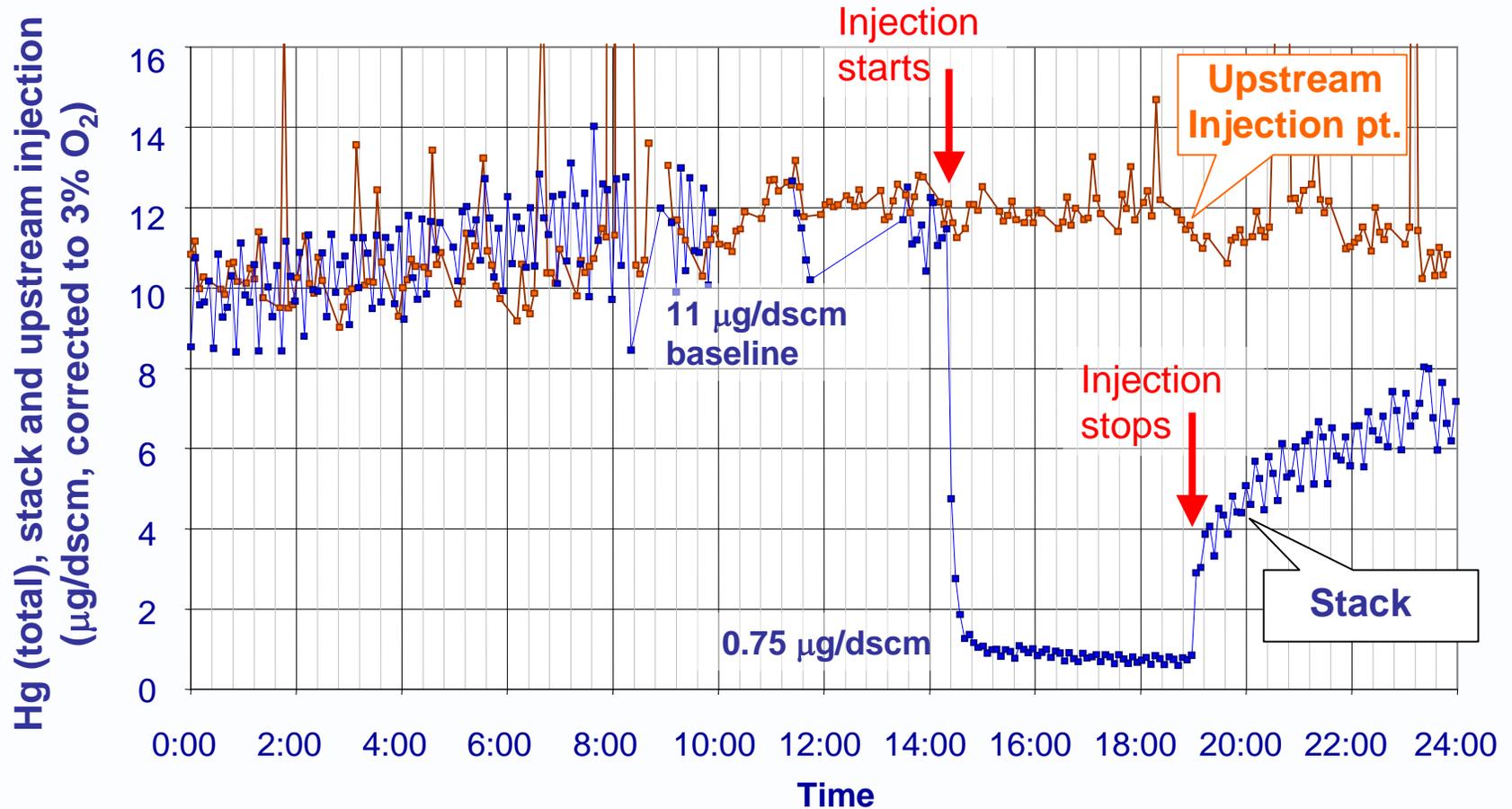
Unit	Dave Johnston 3
Capacity (MWe)	240 (base-load)
Coal Type	Wyodak (PRB)
Sulfur (%)	0.6
Ash (%)	7.6
Cl (ppm dry)	49
Hg (ppm dry)	0.09+/-0.02
Air Heaters	Two Ljungstrom™
Particulate control (SCA-ft ² /kacfm)	Cold-side ESPs (629)
Unburnt C (%)	0.9 – 1.0
Stack flue gas	335°F/6.6% O ₂



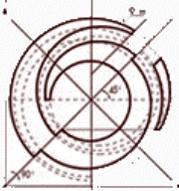


DJ3 Sampling Layout

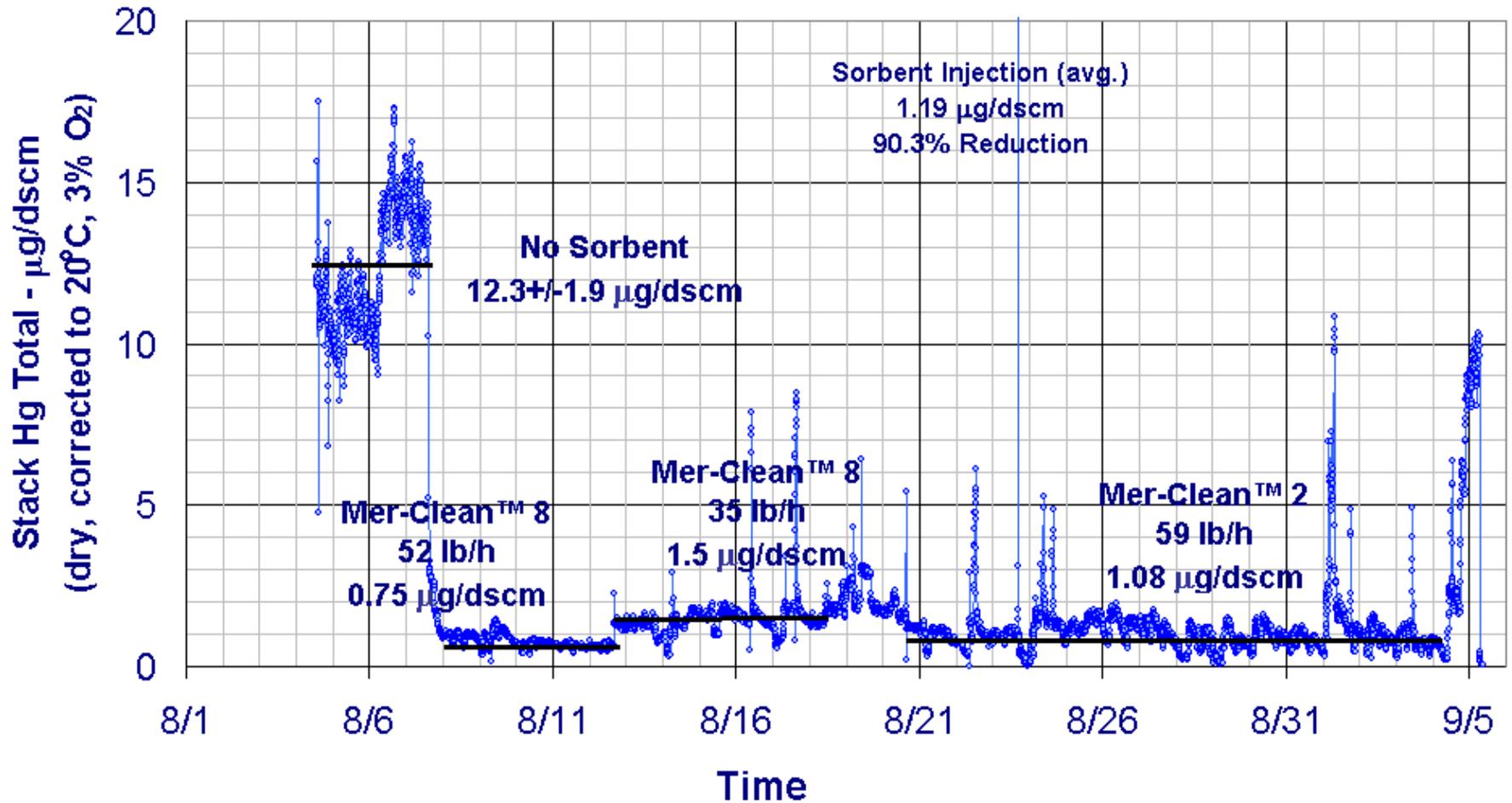




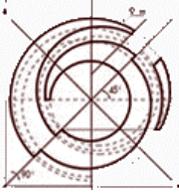
Immediate response, with 90+% mercury removal



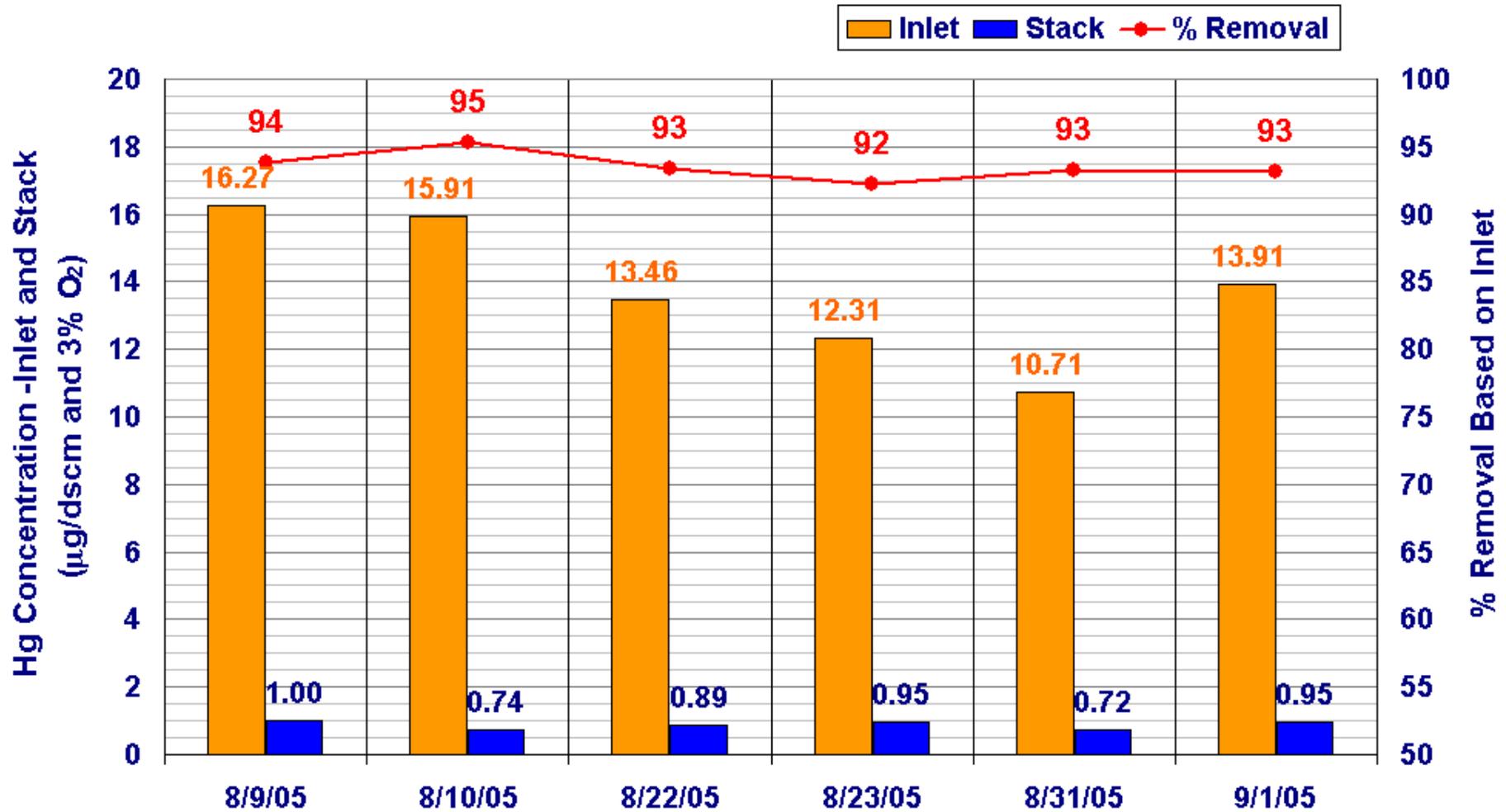
DJ3 Long-Term Testing



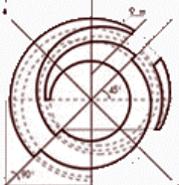
>90% removal achieved over 30 day period



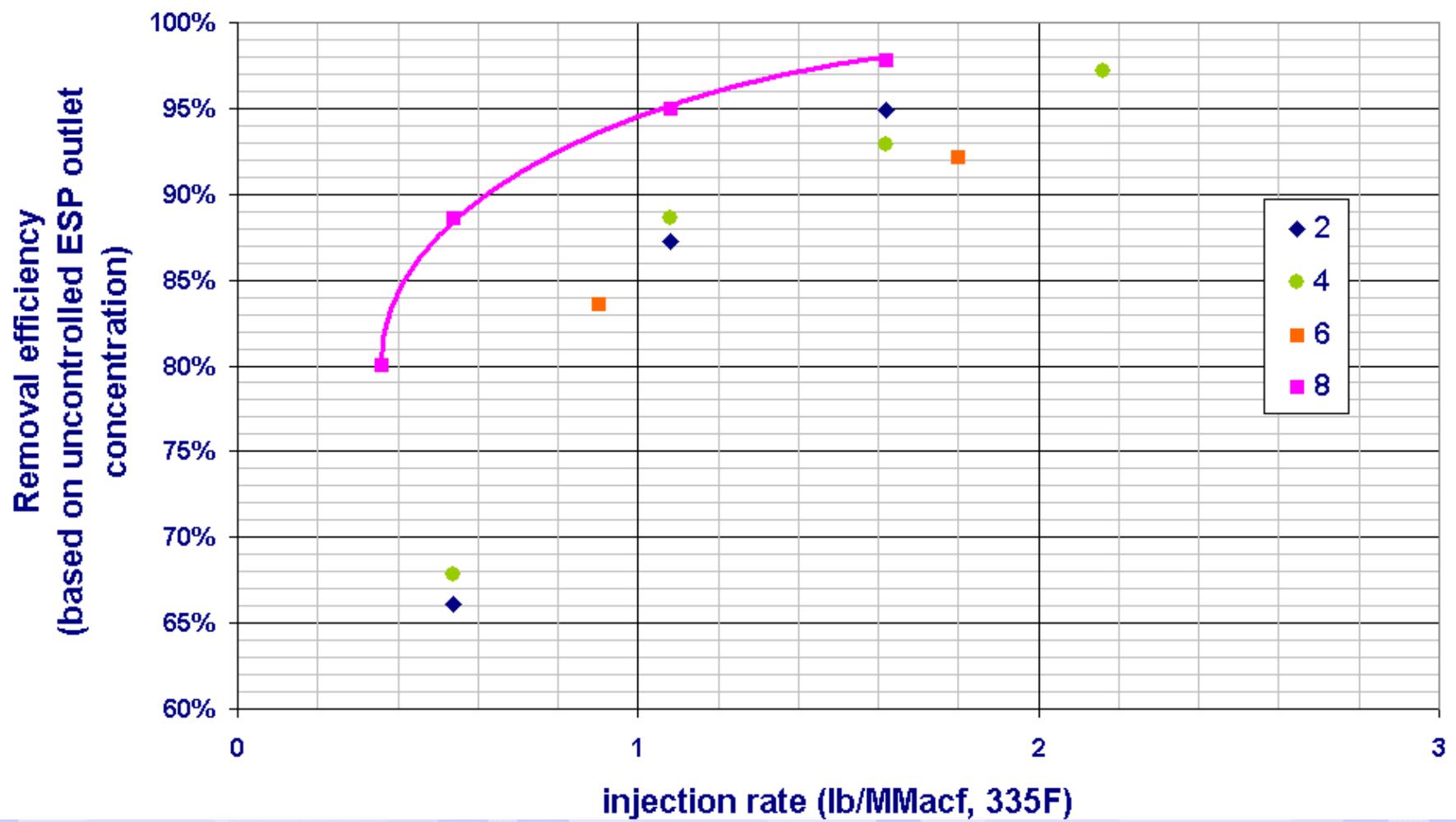
DJ3: Long-term Testing



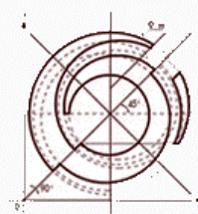
Ontario Hydro validates Mer-Cure™ performance



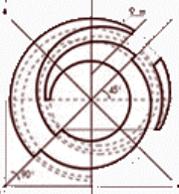
DJ3 Performance Curve



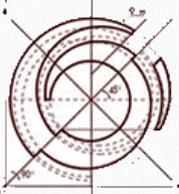
90% removal at 0.6 lb/MMacf and 95% at 1 lb/MMacf



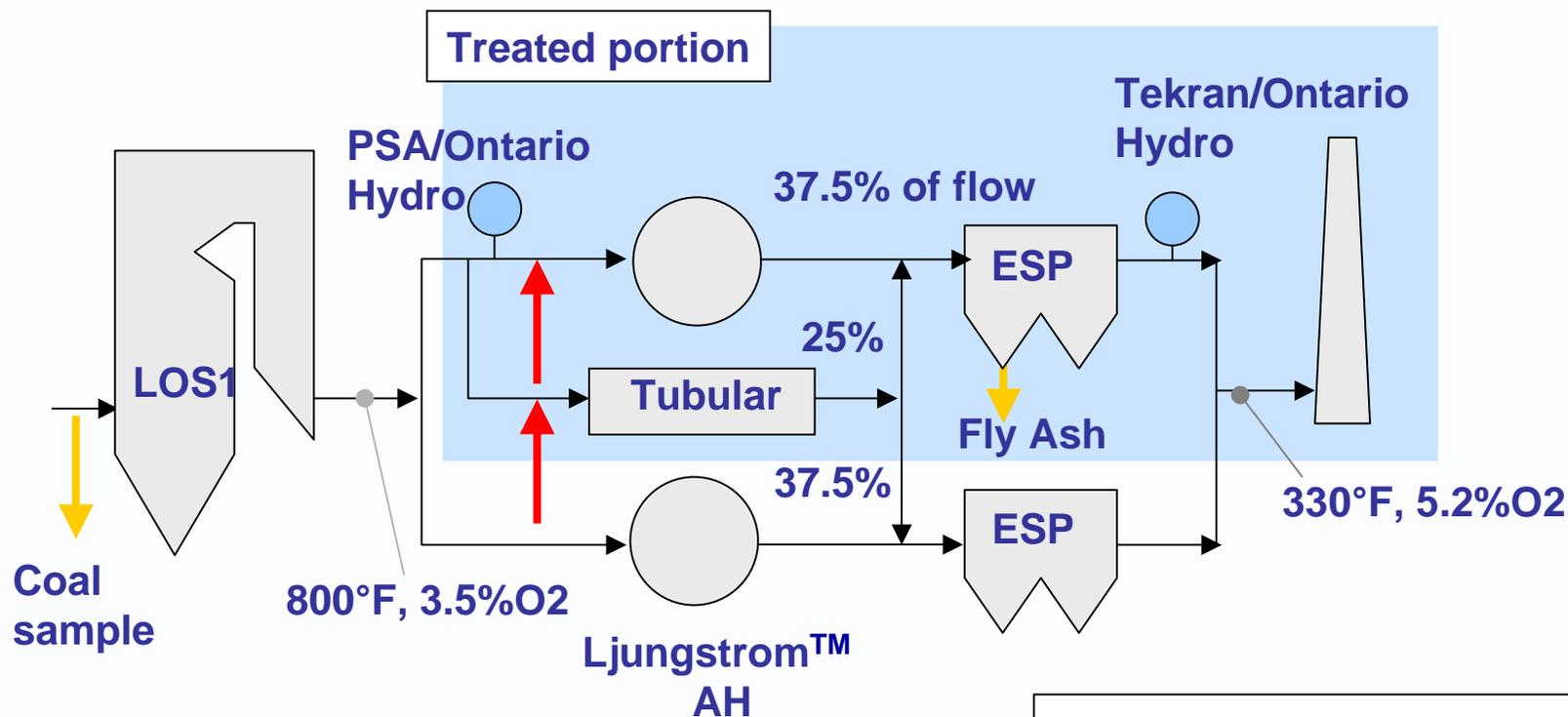
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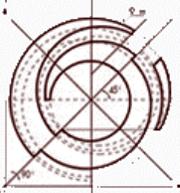
Unit	Leland Olds Unit 1
Capacity (MWe)	220 (~63% treated) (base-load)
Coal Type	ND lignite
S (%)	0.6
Ash (%)	7.8
Cl (ppm dry)	50
Hg (ppm dry)	0.05+/-0.02
Air Heaters	Two Ljungstrom™ + one tubular
Particulate control (SCA-ft ² /kacfm)	Cold-side ESPs (320)
Unburnt C (%)	0.2 – 0.6
Stack flue gas	330°F/5.2% O ₂



LOS1 Campaign Setup



About 63% of total flue gas treated during demo



1st Day of Testing at LOS1

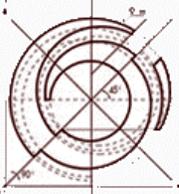


**ALSTOM
Office Trailer**

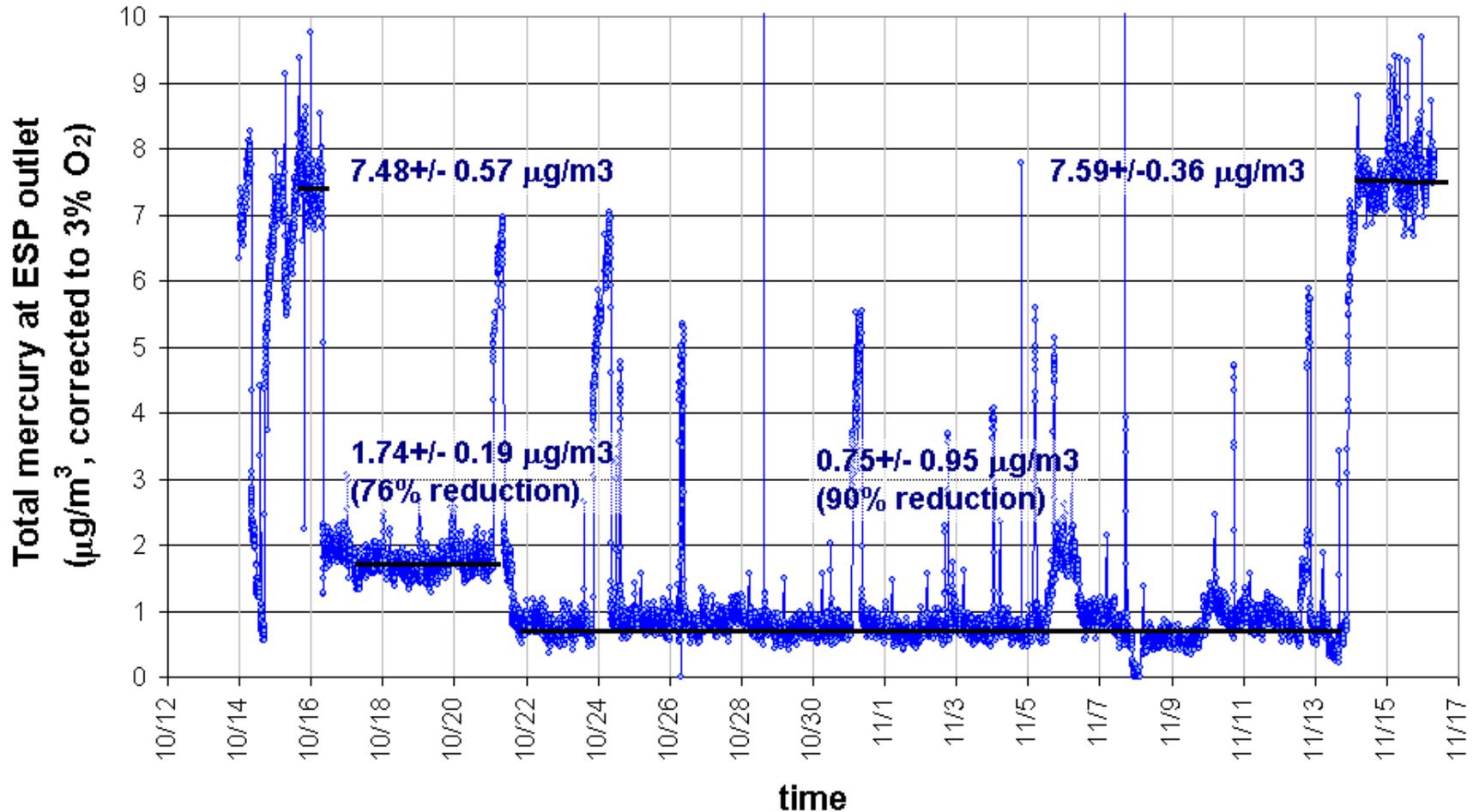


EERC Trailer

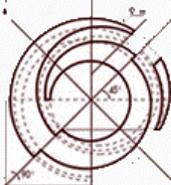
LOS1 - Oct 5, 2005



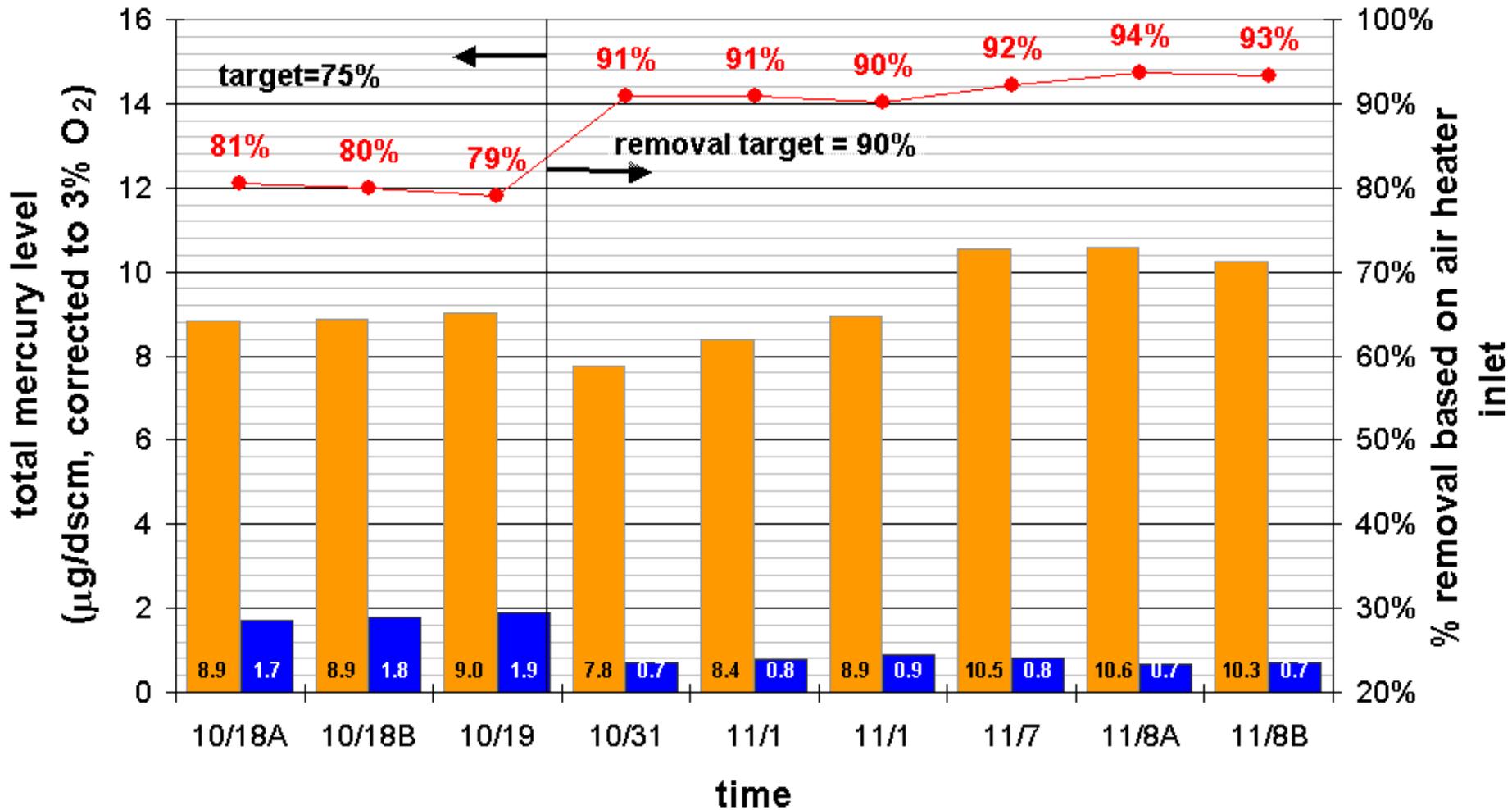
LOS1: Long-Term Testing



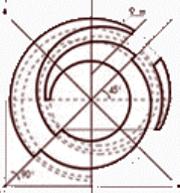
90% removal over 30 day period



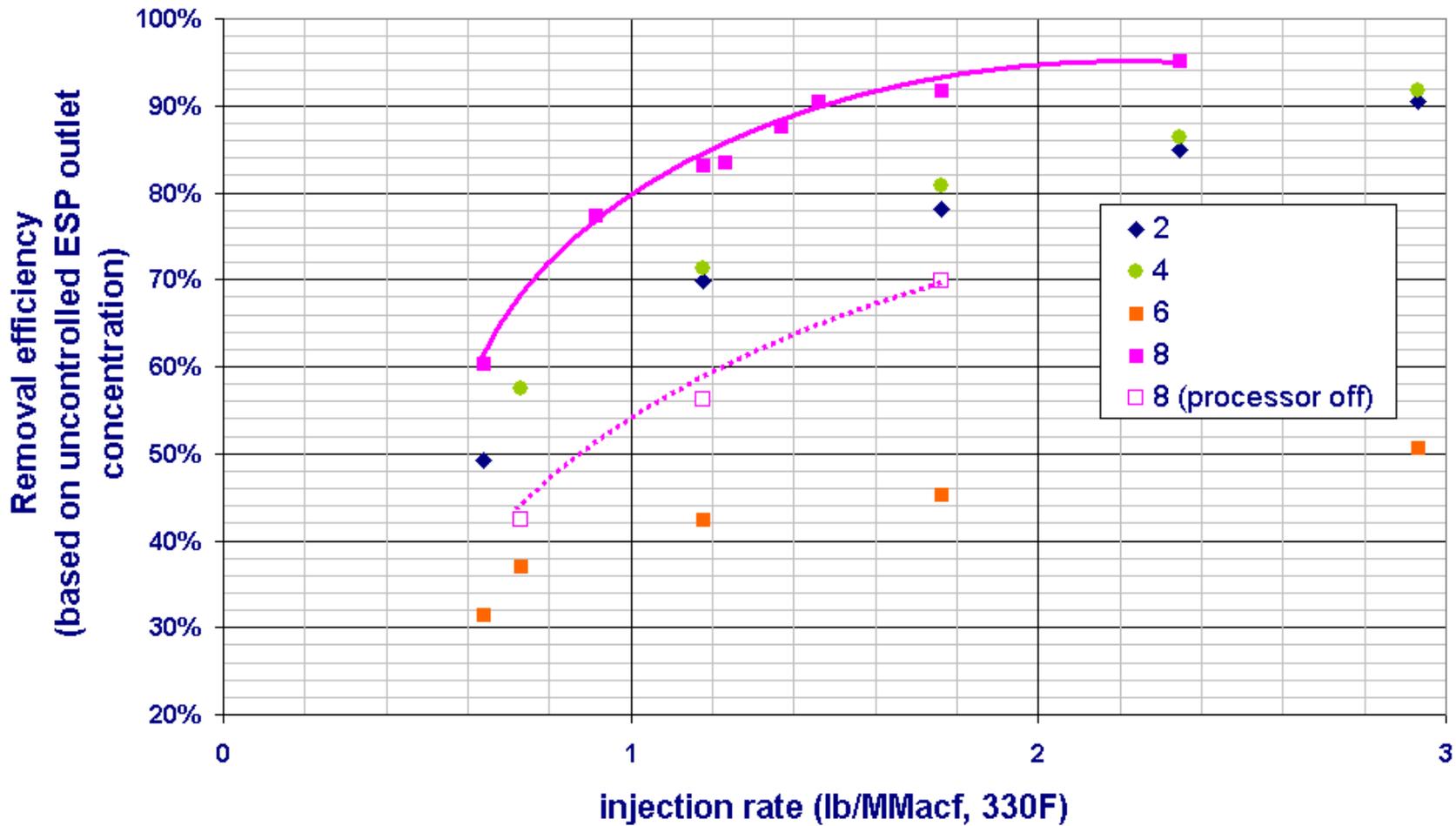
LOS1: Long-Term Testing



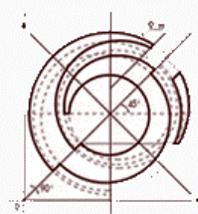
Ontario Hydro confirms Mer-Cure™ performance



LOS1 Performance Curve



90% removal at 1.5 lb/MMacf and 95% at ~2.2 lb/MMacf

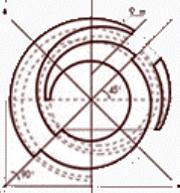


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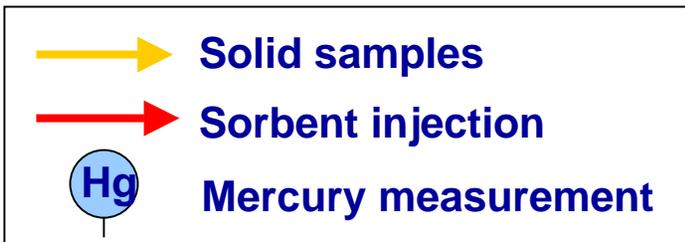
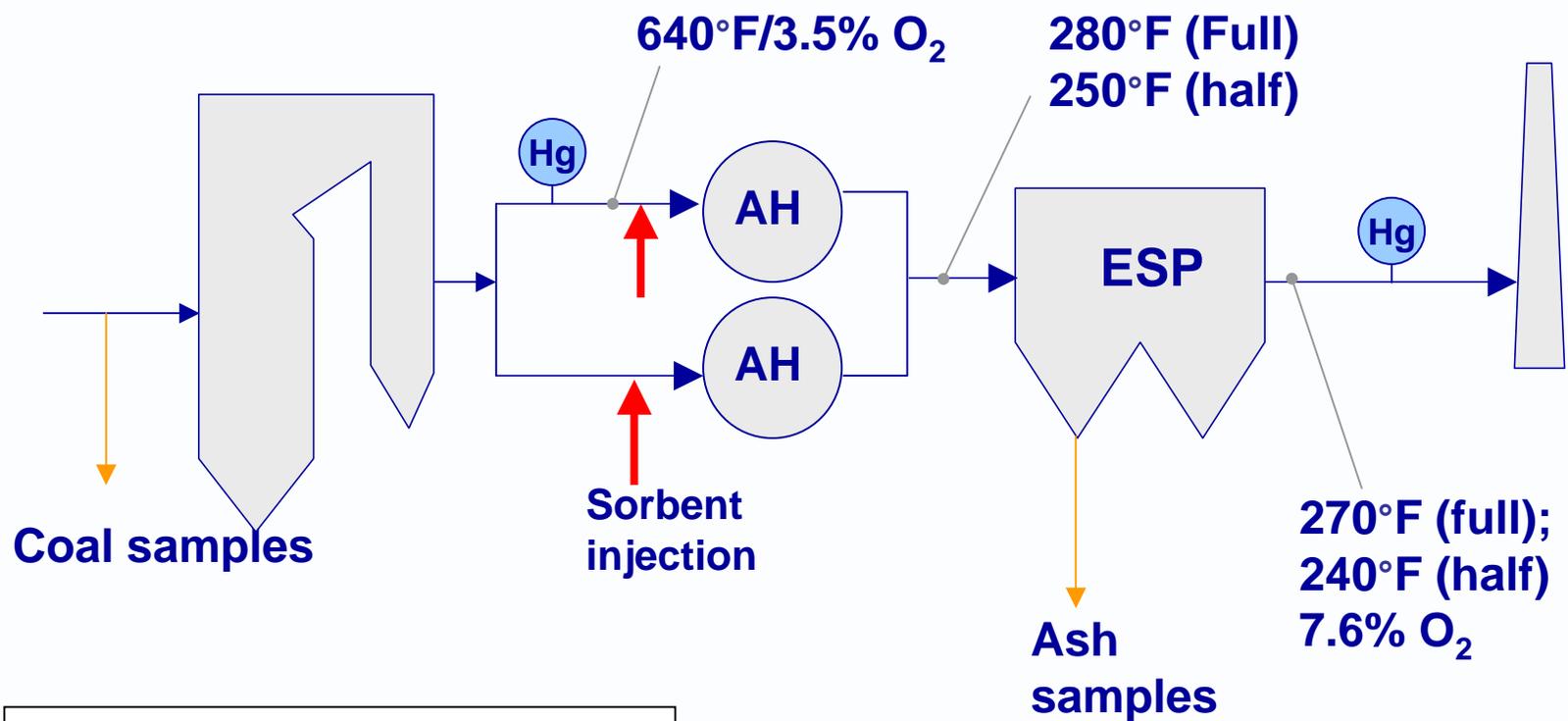


Unit	Portland Unit 1
Capacity (MWe)	170 (cycling)
Coal Type	E. bituminous
S (%)	<u>2.0</u>
Ash (%)	7.6
Cl (ppm dry)	1,150
Hg (ppm dry)	0.1 ±0.03
Air Heaters	Two Ljungstrom™
Particulate control (SCA-ft ² /kacfm)	Cold-side ESP (284)
Unburnt C (%)	8 – 14
Stack flue gas	270°F/7.6% O ₂

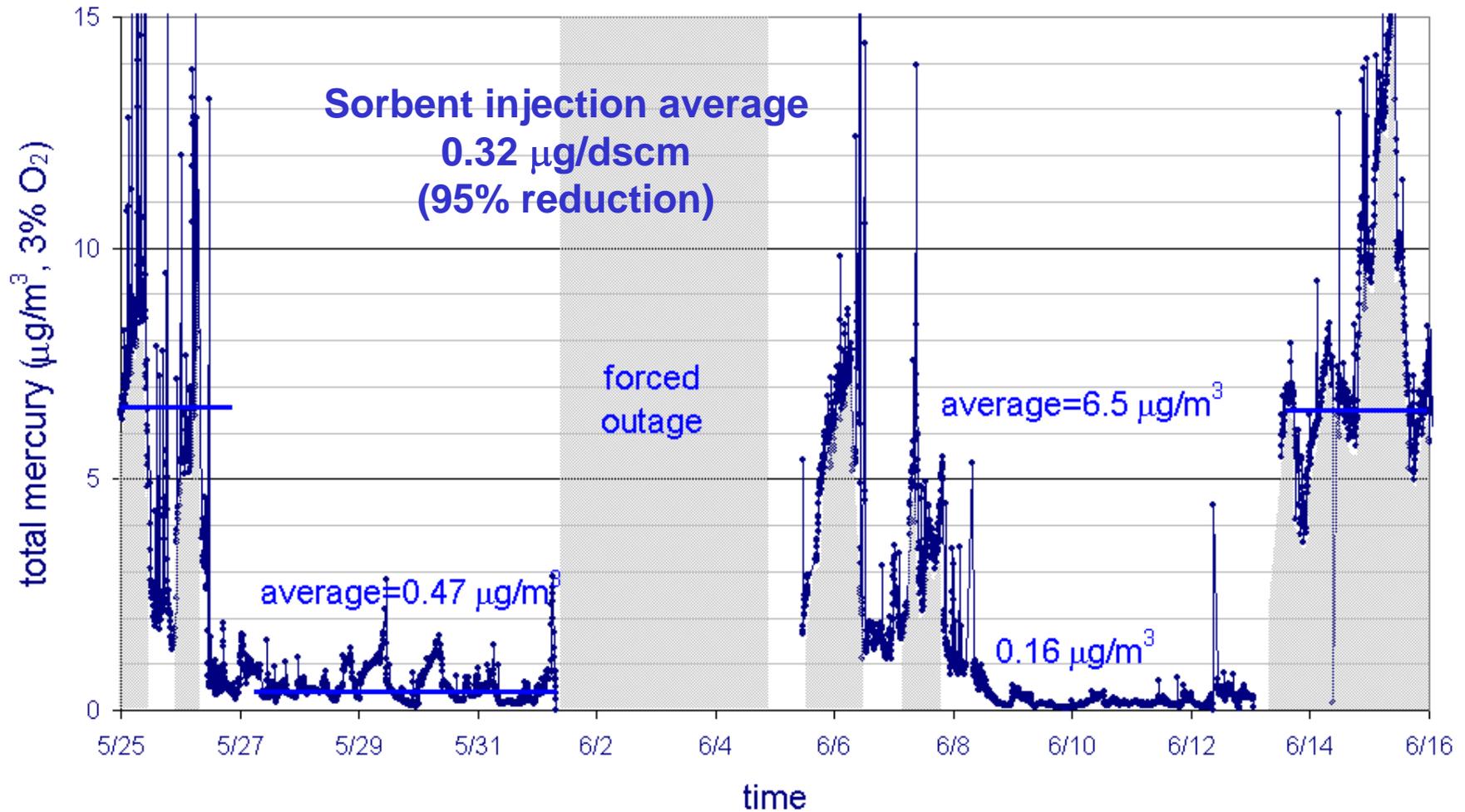




Portland Sampling Layout

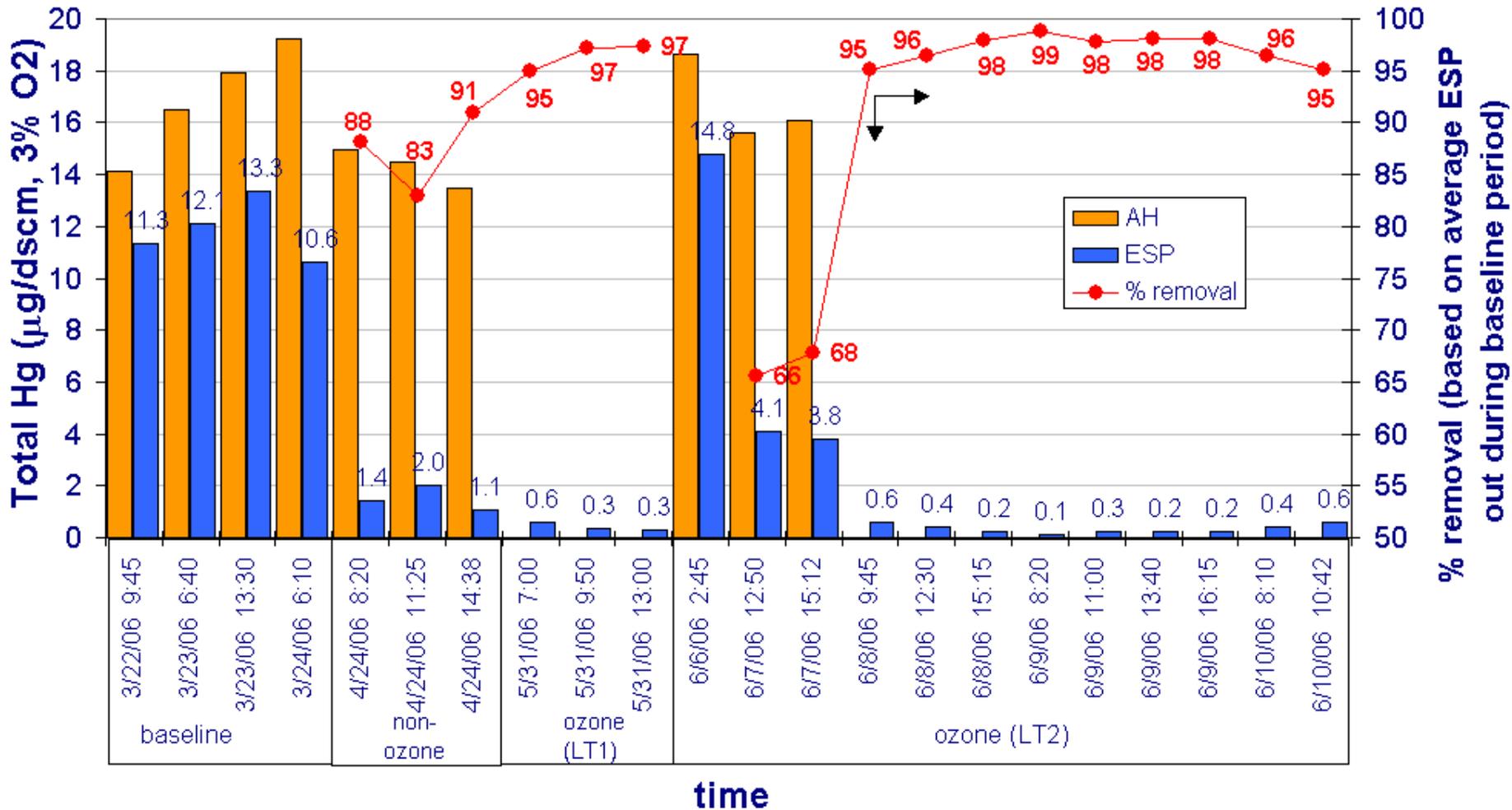


Portland: Long-Term Testing (ozone)



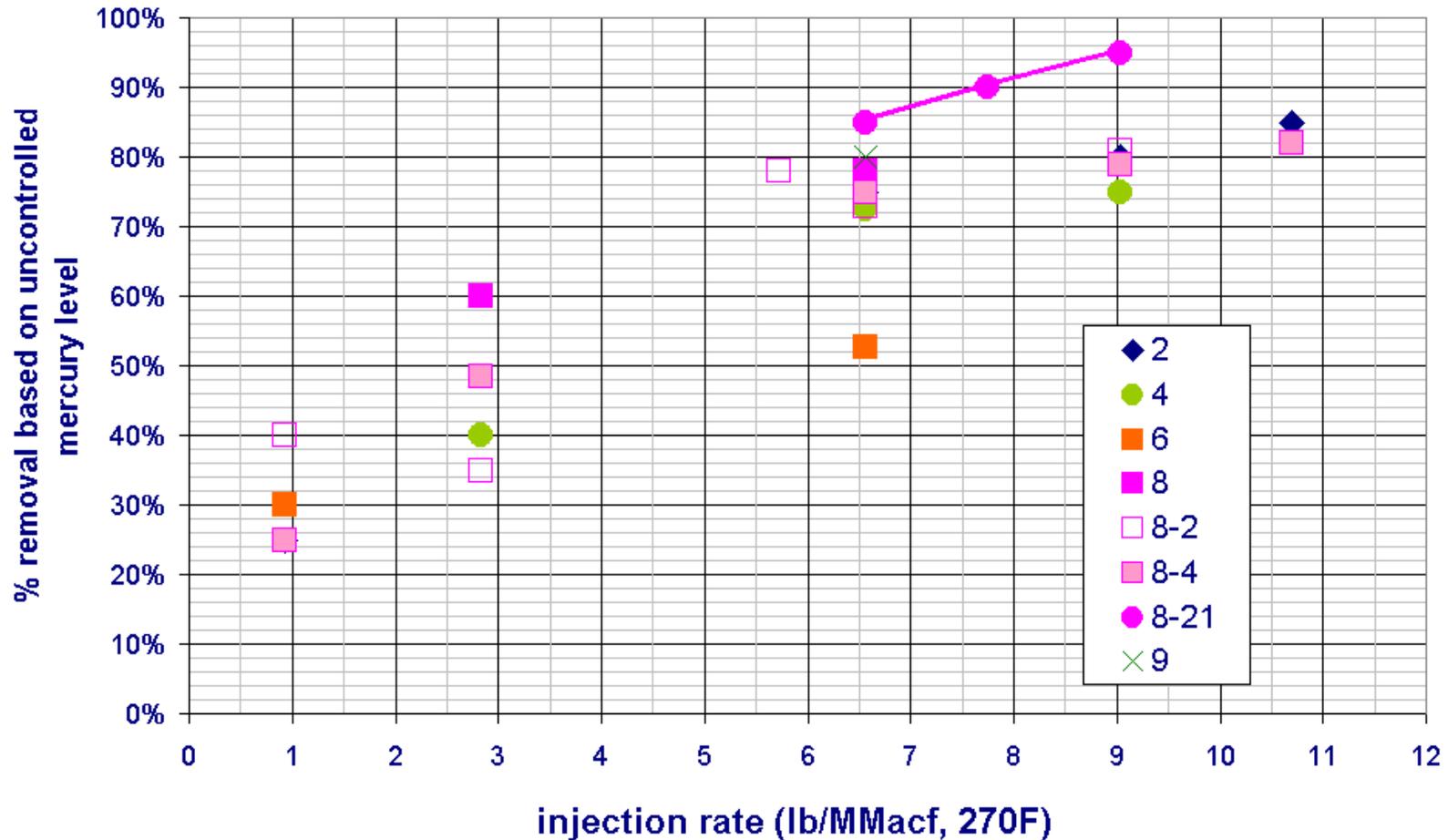
Greater than 90% removal over 14 day period

Portland: Long-Term Testing

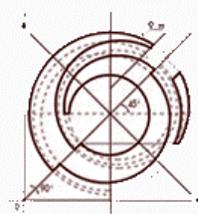


Ontario Hydro validates Mer-Cure™ performance

Portland Performance Curve



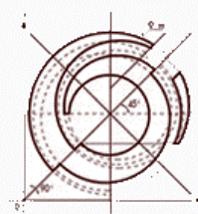
90% removal at 7.7 lb/MMacf and 95% at 9 lb/MMacf



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Summary/Next Steps

- **DOE-sponsored field demonstration has been successfully completed at three host sites**
- **Mer-Cure™ technology could achieve 70+% removal at all three demonstration sites**
 - **90% at 0.6 lb/MMacf at DJ3, 1.5 at LOS1, 7.7 at Portland**
- **Economic analysis will be completed in 1st quarter of 2007**
- **Final report will be issued in 2nd quarter of 2007**
- **Longer term (2 months) demonstration will be conducted as part of DOE/NETL-sponsored Phase III program (under negotiation)**
 - **LCRA's Fayette Unit 3 – ash utilization**
 - **Reliant Energy's Shawville Unit 3 – SO3 impact**